Preliminary Draft

Urbanization in Seoul, Korea - Entomological Considerations

by

Harold D. Newson

June 5, 1972

Site Visit - April 30 - May 14, 1972

INTRODUCTION

Since the other members of this study group will be concerned primarily with the general social and economic health conditions that exist in the Seoul metropolitan area, this report will be confined to the entomological problems of the area and will contain only those other aspects that either are directly concerned with or related to the entomological findings. In the brief time that was available for the study a determined attempt was made to investigate existing problems and to evaluate the resources available and the attitudes of the officials who now are concerned with these matters. Beyond that, however, a considerable effort was made to examine or anticipate those problems that will either be generated or intensified by the current and planned programs for the urbanization and industrialization of the Seoul metropolitan area.

Any attempts to evaluate the findings made in a study of this type must, if they are to be realistic, consider these findings in their proper context - conditions and situations that do or will exist in a rapidly changing and highly populated metropolitan area that is the focal point of the many conflicts inherent in emerging countries of Asia. The significance of these conditions may be, and frequently are, quite different than they would be if found in some of the more developed occidental urban areas in the temperate zones of the world. Proposals for the improvement of conditions or the solution of problems must be within the context of Asian standards and conditions rather than those of the highly industrialized societies of western Europe and North America.

The increasing mobility of the Koreans within their own country and the rapidly expanding international tourist business now being encouraged by the Korean government will have very direct implications on the potential for

human disease dissemination of all types in the Seoul area, but particularly for the arthropod-borne diseases that are endemic to Korea and the more exotic ones found in many parts of Southeast Asia. The movement of large segments of the Korean people from rather isolated rural areas to major population centers will, inevitably, eliminate the natural barriers that have tended to keep some diseases confined within rather clearly defined geographical limits of the country. Individuals infected with malaria or filariasis, diseases now confined to some of the more remote areas of southern Korea, could move to Seoul or other major urban areas and, since suitable vectors for each of these are plentiful in most of the cities, could there serve as infection sources for focal outbreaks of these diseases. Similarly, rapid air travel from many areas of the world could enable infected individuals to travel to Seoul before the clinical onset of a disease and suitable arthropod vectors there could initiate rather extensive disease outbreaks in this populous area. An average of 750 tourists a day were reported arriving by air at Kimpo International Airport during May, 1972, on flights from, among other places, Japan, Philippines, Malaysia and Indonesia. The Korean government has dispatched tourist experts to 23 overseas missions in an effort to a projected increase of approximately 30 per cent per year during the next few years. (1, 2, 3)

In addition to the problems associated with arthropod-borne disease transmission, entomological considerations must also include the variety of problems inherent in the dramatic increase in the use of pesticide chemicals in Korea during the last few years and the even greater increase in use that is forecast for the future. (4). Toxic hazards associated with the transport, formulation and use of these chemicals, toxic residues in food and water and the interrelationship of insecticides used in agriculture and disease vector control

operations are elements that will become increasingly important as Korea proceeds towards its announced objective of adequate food production for its own population and for export. Pesticide formulation or usage, together with other unrelated industrial activities may combine to produce residues in water and food crops that are, in combination, significant health problems and the present trend towards the replacement of persistent "hard" insecticides with less persistent, but much more toxic, materials will certainly increase human and animal hazards.

PRESENT CONDITIONS

A. General.

Water sources, food distribution practices and sewage disposal systems that currently exist in the Seoul metropolitan area provided excellent breeding sites for a variety of medically important insects. Open wells, found in many residential areas and the waste water catch basins and open ditches throughout the city produce large numbers of mosquitoes during the warm months of the year. Privies, sewage holding tanks and the primitive human waste disposal practices commonly used throughout the city provide ideal breeding media for flies and cockroaches which have ready access to public restaurants, food markets and the numerous street food vending businesses that are common in all parts of the urban area. Rapid expansion of the urban area has encroached upon former agricultural areas, primarily rice paddy tracts that now are being filled in to prepare for later building construction. In many of these areas, natural and prepared drainage patterns have been disrupted and the resulting water impoundments during the rainy season produce extensive breeding sites for the species of mosquitoes that are important vectors of malaria and Japanese encephalitis. Some of the above conditions are the result of ancient practices

and will gradually be eliminated as adequate water supplies, sewers, sewage disposal plants and modern food distribution and marketing facilities are developed. Others, however, will certainly persist and perhaps be intensified or increased as a result of planned urban expansion and future construction programs. The relationship of these conditions to the existing and potential insect-borne disease problems will be discussed in some detail in the following sections.

B. Mosquito-borne Diseases.

1. Japanese Encephalitis (JE). This is a very severe virus disease transmitted by a mosquito, Culex tritaeniorhynchus, that breeds primarily in relatively fresh water such as occurs in rice paddies and fresh water swamps. Repeated epidemics of this disease have occurred in Korea with a mortality rate of approximately 30% and marked sequalae in about 50% of the survivors (5). The mosquito vector overwinters in the adult stage and is present in very low numbers in late spring, increases during the rainy season from May through July and its population peaks during mid-August, which coincides with the peak incidence of the disease in humans. Following a major epidemic in 1949 in which there were over 5600 reported cases throughout Korea with over 2700 deaths (5), epidemics occurred in three years cycles through 1958. Since then the three year epidemic cycle has not occurred but the disease persisted at or near epidemic levels in most subsequent years until 1969 when there was a precipitous drop in the number of reported cases and the reduced level of the disease has persisted through 1971. (Figures for the incidence of this disease in the Seoul area only were not available.) Whatever the validity of the available statistics on this disease, there is no question but what it has been, and will continue to be, a serious problem in Korea. Historically, this has been mainly a rural disease and clinical cases have been seen primarily in Korean

children rather than adults, so an extensive immunization program has been conducted in rural areas of the country during the past six years with approximately 100,000 children per year receiving immunizations during this period (6).

It is the impression of both the Korean Government Health Ministry and the World Health Organization Japanese Encephalitis Vector Research Unit (WHOJEVRU) in Seoul that there are changes occurring in the epidemiological aspects of this disease. These changes could be very significant. Health Ministry officials stated the disease was becoming more common in older adults and attributed this to the immunization program for children. Field studies by WHOJEVRU have shown that mosquito vectors now are much more numerous in suburban than in rural areas and have the impression, yet to be definitely substantiated, that human infections with this virus are becoming more common in urban-suburban localities than in rural areas (7, 8). The marked decrease in vector mosquitoes in the rural habitats they attribute to the extensive use of insecticides in rice farming. At the same time, a sharp increase in vector populations has occurred in unfarmed paddies and swamps located in many urban-suburban areas now being developed for building and industrial sites. A number of areas of this type were seen in Yongdungpo-Ku, Yongdang, Dongdaemun Ku and Songpuk-Ku and most of these sites were among or immediately adjacent to slums or concentrations of squatters dwellings that provided minimal protection from mosquitoes. The Japanese encephalitis immunization program in the Seoul area is minimal at this time so there now are large susceptible segments of the population of the metropolitan area living in areas where outbreaks of Japanese encephalitis are quite likely to occur. The potential for future disease outbreaks in these areas should not be minimized.

Little information is now available concerning what levels of insecticide resistance, if any, have developed in the Culex tritaeniorhynchus populations

of either Seoul or other parts of Korea. Tests conducted by WRAIR/NEVRU indicate some resistance exists to certain chlorinated hydrocarbons and there also is evidence to indicate some developing resistance to organophosphorous compounds. With the wide variety of insecticides now approved for use in agriculture it is virtually certain that insecticide resistance in vector populations will become both widespread and intensive. Such a situation now exists in parts of California where several important mosquito vectors, because of insecticides used in agriculture, now are resistant to every chemical insecticide available for their control (9). Efforts are being made in Korea now to develop alternate mosquito control methods to supplement or replace chemical control.

Insect control programs in the Seoul metropolitan area are conducted by each of the nine regional health centers and are generally restricted to the localities where general sanitation is the poorest and insect problems most severe. Insect control operations are combined with disinfectant spraying designed to reduce insect populations and/or bacterial contamination. Only one Health Center (Sungdong-Ku) was visited but the program there was said to be typical of those in other Centers and was believed to be one of the best in the city. In the area served by this Center the treatments were restricted to 17 selected subdivisions (Dongs)-out of a total of 44, and were restricted to those localities within each Dong that had the worst sanitary problems. During the warm months of the year each of the selected localities was treated weekly on a prescheduled cycle. The chemicals used might be insecticides, disinfectants or a combination of the two and the application was made by workers who had been trained and certified by the Seoul City Health Department. Chemicals used in this program were designated and purchased by the city of Seoul. Since the operation was not observed it is not possible to comment concerning the effectiveness of the operation. Given the limited number of

people and the few equipment items now available in this program, however, it is quite apparent that the existing organization would not be adequate to cope with any extensive Japanese encephalitis outbreak that might occur in the Seoul metropolitan area.

2. Malaria. Since the 1950-53 period there has been a progressive reduction in the number of indigenous cases of malaria in Korea. This has been in the absence of any organized malaria control program and is thought to be the result, in part, of the increased use of insecticides in rice cultivation with a resulting reduction in the numbers of the mosquito vector, Anopheles sinensis, throughout most of the country. The only remaining endemic focus is in the southern part of the country, Kyong Sang Pukdo, a mountainous area northeast of Pusan. The area where malaria is still actively being transmitted is presently undergoing changes that, in the opinion of the Korean Health Ministry, will reduce the vector mosquito populations below critical levels and result in the cessation of malaria transmission. Under the present development program a rail line has been extended into this region and a major land reclamation project has been started that will involve the filling of many mosquito breeding sites. Insecticide usage in agriculture there is expected to increase markedly and should reduce Anopheles sinensis populations since this species, like the vector of Japanese encephalitis, breeds primarily in rice paddies and similar accumulations of fresh water. Malaria in Korean Army servicemen returning from Vietnam has not been a significant problem and a screening program has been initiated to detect and treat any infected individuals prior to their departure from Vietnam. Indigenous cases of malaria in recent years have been almost exclusively Plasmodium vivax although there has been some transmission of P. falciparum through the common use of hypodermic needles by narcotics addicts. The same types of habitats in and around the

Seoul area that are suitable for the breeding of Culex tritaeniorhynchus, i.e., unused rice paddies and fresh water swamps, also are ideal breeding sites for Anopheles sinensis and as long as these exist there will be numbers of this mosquito species in the Seoul area. Malaria infected individuals coming into Seoul from either endemic areas in Korea or outside the country could serve as infection sources for localized outbreaks of this disease but unless conditions in Korea are drastically changed it appears quite unlikely that any widespread malaria epidemics will occur there.

3. Other. There is a possibility that other mosquito-borne diseases might occur in the Seoul metropolitan area but it is rather unlikely that any of them will become major, persistent problems. As with malaria, individuals infected with these pathogens might serve as sources of infection but the ecological conditions in the vicinity of Seoul generally are not suitable for the continuation of these diseases in the absence of rather significant numbers of infected humans. Filariasis (Brugia malayi) is endemic in the southernmost part of Korea and an Cheju-do but the major mosquito vector, Aedes togoi, is found primarily in coastal areas rather than in inland areas such as Seoul. Anopheles sinensis might serve as a vector of B. malayi but there is no evidence thus far to indicate that it plays a major role in the transmission of this parasite in the endemic areas of Korea. Of the mosquito-borne diseases that occur in other parts of Asia, dengue or dengue hemorrhagic fever are probably the most likely to be brought into Korea by means of infected individuals entering the country. Health officials and medical researchers are quite aware of this possibility and through the recently organized Institute of Tropical Medicine, are actively engaged in diseminating information concerning these diseases to medical practitioners in Korea (12, 13).

Aside from disease transmission, mosquitoes can be expected to be major pests in Seoul and the surrounding areas as long as the current sanitary situations remain. Open wells, water catch basins, polluted streams, canals and rivers and open ditches all serve as excellent breeding sites for a number of pest mosquito species and, until these sources are either eliminated or significantly modified, there will be a significant number of pest mosquitoes in the urban areas throughout the warm months of the year.

C. Houseflies and Blowflies.

The general sanitary conditions in the Seoul metropolitan area provide almost limitless breeding sites for both houseflies and blowflies. Privies, sewage holding tanks and open ditches containing copious amounts of organic matter are excellent for the proliferation of houseflies while the blood and waste animal tissues discarded or spilled in urban open markets provide ideal media for the development of blowflies. Both groups of flies have free access to human fecal deposits, raw foods sold in the open markets and prepared foods sold in either unscreened restaurants or the many food dispersing carts located throughout the city. Given the habits of these flies and the high incidence of enteric parasites and pathogens in the residents of Seoul, these insects certainly enhance the dissemination of enteric pathogenic organisms (14, 15, 16, 17). These fly problems will be remedied only through the development of adequate sewage and waste disposal, improved food distribution systems and screening of food serving establishments in the Seoul metropolitan area. Obviously, such developments will upgrade the overall sanitary conditions and will undoubtedly eliminate or reduce the present high incidence of gastrointestinal disease as well as eliminating many of the fly breeding sites that abound throughout the city at this time.

D. Cockroaches.

The traditional Korean homes and buildings provide generally unsatisfactory conditions for large cockroach infestations, but the new, high rise buildings with central heating now being constructed in the Seoul area are quite different and, predictably, cockroach infestations are becoming increasingly important problems. Koreans traditionally, have associated cockroach infestations with prosperity - calling them "good fortune bugs" - and have been reluctant to kill them. This attitude, however, appears to be changing. Cockroaches, like houseflies, roam freely from human fecal accumulations to food and with the sanitary conditions that exist in Seoul are very capable of serving as effective disseminators of enteric pathogens (18). New office buildings and apartments now have cockroach infestations that will require effective control measures. The many new apartment buildings being planned and built will require effective preventive treatments with insecticides if additional problems are to be avoided. Cockroaches are primarily pests in most occidental urban areas but in Seoul they must be considered to be potentially important vectors of a variety of enteric diseases.

E. Plague.

The potential for plague introduction exists. Full evaluation of the situation must include information concerning rodent and possible domestic animal reservoirs as well as their fleas and will be made in cooperation with Dr. Barbehenn (sp?).

F. Louse-borne Diseases.

While both epidemic typhus and louse-borne relapsing fever have appeared in epidemics in the past, neither of these diseases ~~are~~ is presently considered to be a significant public health problem in Korea (5). The incidence of

pediculosis in the Korean population, as with these two diseases, has progressively diminished as the general standard of living has improved. Barring major man-made or natural disasters it is rather unlikely that either of these diseases will become a significant problem in Seoul.

G. Pesticide Toxicity and Residue Problems.

No agricultural pesticides presently are synthesized in Korea. These chemicals either are imported as technical grade materials that are then formulated for use in the country or are imported in the formulations to be used. Before import permits can be obtained, either for the technical grade or finished formulations, the importer or foreign manufacturer must request testing by the Korean government and must specify the purpose for which the chemical is to be used and marketed. These requests then are reviewed and, if approved, the government issues a permit for the importation of sample lots that are then tested by the National Institute for Agricultural Materials Inspection. The testing program includes phytotoxicity, animal toxicity, laboratory and field tests of the materials for the purposes for which they are to be used. Field tests are conducted at two test areas, one in the southern and one in the northern part of the country, and usually are continued for a period of two years. Upon completion of the tests, the data are reviewed and if the Institute is satisfied with the results and the need for that type of material is evident, it is recommended that the import license be issued. For products that are approved for import there are certain requirements and specifications for the label that must be placed on each package of the material that is offered for sale. Required information includes the following: Directions for use, warnings as to the hazards associated with use, the chemical name(s) and concentrations of the ingredients. Information on how to use new materials that are placed on sale

is disseminated through either the Office of Rural Development (apparently the equivalent of the United States Cooperative Extension Service) or by the local or area representatives of the manufacturer or formulator. To protect consumers the Institute for Agricultural Materials Inspection also has the legal right to enter premises where pesticides are stored and obtain samples for analysis to determine whether or not the product conforms with the information contained on the label.

There is considerable concern regarding the environmental and toxicological hazards associated with the use of pesticides of all types (21). In past years there have been many chemicals and formulations available for use by the farmers but it is felt that the selection of proper materials, in general, is beyond the competence of many of these individuals (22). For this reason there now is a strong emphasis on reducing the number of chemicals approved for agricultural use and to eliminate, as soon as possible, all of the persistent organochlorine pesticides that might cause environmental pollution or toxicological problems. DDT now is approved only for use on trees and will be phased out completely as soon as suitable substitutes can be found for the presently approved uses. Other organchlorine insecticides are to be eliminated from use on food crops as soon as possible. While these substitutions will minimize the insecticide build-up in the food chain, the substitute insecticides are, generally, much more toxic and will create greater toxicological hazards. Many of the less persistent insecticide chemicals that have been substituted for the organochlorine compounds (Figure 1) are much more toxic and the use of these materials has resulted in numerous accidental poisonings. To minimize this hazard an arbitrary LD_{50} has been established for pesticide chemicals and import permits are not now approved for any chemical or formulation which exceeds this limit. Insecticide residue

tolerances now approved for food crops are those established by WHO/FAO. It is the feeling of most Korean scientists interviewed that the eating habits of the Koreans are sufficiently different from other countries that specific standards should be established for this country and numerous studies are now being conducted to determine suitable residue tolerances for Korea.

Studies conducted by the Institute for Environmental Pollution Research, Yongsei University, have documented the existance of chemical pollution in rice and, with the anticipated increase in pesticide usage and industrial operations, it can confidently be predicted that this problem will increase. Organic mercury levels in tested samples of Korean rice have exceeded the upper acceptable limits recommended by FAO and high levels also have been found in rice imported from Japan. It is felt that the primary source of Mercury in the Korean rice is from mercury base disinfectants used by farmers to control rice blight (23). This type chemical is not approved for use on food crops but is sold as a bacteriological disinfectant. It is, however, available on the open market and is commonly used by rice farmers despite the fact that it is not legal to use germicidal solutions for this purpose. It seems quite probable that other heavy metals from industrial sources may present food contamination problems in the future, either through direct fallout from factories onto croplands or through fallout contamination of water used to irrigate crops. Monitoring efforts have been started but it is quite obvious that these should be expanded as soon as resources can be made available for this purpose.

An additional problem associated with more extensive use of insecticides is the possibility of accidental contamination of foods or other materials being stored or transported with these toxic chemicals. Numerous examples of this have occurred in many parts of the world and similar episodes can

be expected in Korea unless suitable regulations concerning the storage and transport of toxic chemicals are enacted and enforced. With the extensive use of more toxic pesticides there also will be an increase in other accidental poisonings, to workers in formulating plants as well as to individuals using these materials. It is essential that some mechanism be established to minimize these hazards and to develop suitable methods for providing appropriate medical treatment for individuals who become intoxicated with these chemicals.

Recommendations

1. Strong support should be provided for the World Health Organization Japanese Encephalitis Vector Research Unit - National Institute of Health program to develop valid basic data for use in monitoring and controlling Japanese encephalitis in Korea. Developed adequately this information will enable Korean health officials to abort or confine outbreaks of this disease.
2. Efforts should be made to expand the insect control programs now conducted by Seoul City Health Centers to include the treatment of existing mosquito larval breeding sites suitable for the production of Culex titaeniorhynchus, i.e., fresh water impoundments, swamp and unfarmed rice paddies.
3. Measures should be established to prevent or minimize water impoundments in urban and suburban areas being developed for building or industrial sites.
4. Pre- and post-occupancy cockroach control programs should be established for all new office and apartment buildings. Emphasis should be concentrated on kitchens, food preparation and storage areas and garbage and trash storage locations. In support of this, formal legal action should be taken to establish and monitor performance standards for individuals and companies engaged in this work.
5. If not now established a national program should be started to disseminate information concerning the diagnosis and treatment of pesticide chemical poisonings - perhaps along the lines of regional poison control centers.

6. The program for monitoring toxic residues in food, feed and water should be strengthened and expanded.

7. Consideration should be given to legislation and the enforcement of standards concerning the safety aspects for transportation and storage of toxic chemicals, to include pesticides.

Visits and Tours

May 2nd - Public Health Section, Republic of Korea Ministry of Health and Social Affairs.

May 3rd - National Institute of Health; World Health Organization Japanese Encephalitis Vector Research Unit.

May 4th - Seoul Metropolitan Government Institute of Hygiene.

May 5th - Radiation Agriculture Research Institute.

May 6th - Songdong Ku Health Center.

May 7th - Selected areas of Songdong Ku with most serious sanitary problems.
Site of Satelite City in Yongdung.
Expanding industrial area in Yongdungpo Ku.
South Gate Market in Seoul.

May 8th - Department of Preventive Medicine and Institute of Tropical Medicine, Yongsei University Medical College.
National Institute for Agricultural Materials Inspection.

Prepared by the Korean National Institute for Agricultural Materials Inspection.

License list (Insecticides 1972)

Insects name (in English)	number* of license insecticides	Remarks
1. Rice stemborer	24	19 Organophosphorus 10 carbamate 2 Organochloric 1 Carbamate 1 Chlorophenamidine
2. Plant hopper	12	12 Organophosphorus 6 Carbamate
3. Leaf hopper	4	3 " 1 "
4. Grass leaf roller	6	6 "
5. Aphid	26	23 " 1 Carbamate 2 Organochloric
6. Striped Cabbage worm	4	2 Organophosphorus 2 Carbamate
7. Common Cabbage worm	8	4 Organophosphorus 2 Carbamate 1 Organochloric 1 arsenate
8. Leaf roller	18	17 Organophosphorus 1 Carbamate
9. Mite	16	11 " 2 Chlorophenamidine 2 Mineral oil 3 etc
10. Citrus leaf miner	5	4 Organophosphorus 1 Carbamate
11. Beetle	9	8 " 1 Mineral oil
12. Peach fruit moth	3	3 "
13. Lace bug	2	2 "
14. Jan ispiri Okamoto	2	2 "
15. Oriental tobacco budworm	3	2 " 1 Organochloric
16. Mulberry shoot	2	2 Organochloric
17. Tobacco cutworm	5	5 Organophosphorus

* Number of formulations rather than separate insecticide chemicals

Fig. 1

18. Pine caterpillar	16	11 Organophosphorus 5 Organochloric
19. Fall webworm	6	6 Organophosphorus
20. Pine leaf gall midge	5	5 "
Total	1 48	

Persons Visited

Chin Thuck SOH, Professor of Parasitology and Director, Institute of Tropical Medicine, Yonsei University.

Sook Pyo KWON, Professor, Department of Preventive Medicine and Director, Institute for Environmental Pollution Research, Yonsei University.

Myung Ho KIM, Professor, Department of Preventive Medicine and Public Health, College of Medicine, Yonsei University.

Do Yeon CHO, Chief, Biological Assessment Division, National Institute for Agricultural Materials Inspection.

Song Woo LEE, Director, Public Health Section, Ministry of Health and Social Affairs, Republic of Korea.

Kyoung Ho KIM, Director, Department of Virology, National Institute of Health.

H. I. REE, Chief, 1st Entomology Division, Department of Virology, National Institute of Health.

Pierre. H. A. JOLIVET, Project Leader, World Health Organization Japanese Encephalitis Vector Research Unit.

Chae Joo PARK, Director, Seoul Metropolitan Institute of Hygiene.

Jong Dae SHIN, Chief, Bacteriological and Serological Section, Seoul Metropolitan Institute of Hygiene.

Hyo Sang KIM, Chief, Public Nuisance Measurement, Seoul Metropolitan Institute of Hygiene.

Sang Chil SHIM, Director, Radiation Agriculture Research Institute (RRIA), Office of Atomic Energy, Republic of Korea.

Han Kwon SHIN, Chief, Plant Protection Division, RRIA.

In Shik LEE, Director, Sungdong Ky Health Center, Seoul.

Newman HALL, Chief, Office of Science and Technology, USAID, Korea.

References

1. Pak, T.J. 1972. Personal Communication.

2. Anon. 1972. Korean Times, May 6, 1972.

3. Anon. 1972. Korean Times, May 14, 1972.

4. Anon. 1971. The Third Five-Year Economic Development Plan 1972-1976. Government of the Republic of Korea.

5. Anon. 1969. Yearbook of Public Health and Social Statistics, Ministry of Health and Social Affairs, Republic of Korea.

6. Park, S. B. and K.H. Kim. 1971. Antibody Response for Japanese Encephalitis Virus in Primary School Children Following J.E. Vaccination in Korea. 1969. (Abstract) Yongsei Reports on Tropical Medicine 2(1):10.

7. Lee, K.W. et al. 1971. Japanese Encephalitis Vector Studies in Korea: Light Trap Surveys. World Health Organization VBC/ 71, 324.

8. Self, L.S. et al. 1971. Ecological Studies on Culex tritaeniorhynchus in the Republic of Korea in 1971. World Health Organization VBC/ 71, 332.

9. Ree, H.I. et al. 1971. Japanese Encephalitis Vector Studies in Korea: Adult Mosquito Populations. World Health Organization VBC/ 71, 325.

10. Peters, Richard. 1972. Personal Communication.

11. Shin, J.C. and L.S. Self. 1971. Toxicity of Agricultural Chemicals to Larvivorous Fish in Korean Rice Fields. World Health Organization VBC/ 72, 342.

12. Koh, T.Y. et al. 1971. Epidemiological and Physical Notes on Brugia malayi Infection in Cheju Island, Korea. Ibid 2(1):110-121.

13. Anon. 1969. The Report of National Institute of Health, Republic of Korea. Vol. 6.

14. ____ 1970. Ibid (?) Vol. 7.

15. Kim, C.H. et al. 1971. Prevalence of Intestinal Parasites in Korea. Ibid 2(1):20-43.

16. Lew, Joan. 1971. The Biological Characteristics of V. cholerae of the Cholera Epidemic in Korea. (Abstract) Ibid 2(1):12.

17. Ch i, T.K., I.K. Chang and J. Lew. 1971. Bacteriological Survey of Enteric Infections in Seoul. Ibid. 2(1):44-52.

18. Greenberg, Bernard. 1971. Flies and Disease. Vol. I. 856 pp. Princeton University Press.

19. Roth, L.M. and E.R. Willis. 1957. The Medical and Veterinary Importance of Cockroaches. Smithsonian Misc. Coll. Vol. 122, No. 12. 49 pp.

20. Rust, J.H. et al. 1971. The Role of Domestic Animals in the Epidemiology of Plague I. Experimental Infection of Dogs and Cats. Journal of Inf. Diseases. 124(5):522-526.

21. Rust, J.H. et al. 1971. The Role of Domestic Animals in the Epidemiology of Plague. II. Antibody to Yersinia pestis in Sera of Dogs and Cats. Ibid. 124(5):527-531.

22. Kwon, Sook Pyo. 1971. The Korean Experience in Saving the Human Environment. Paper presented at Conference on Saving the Human Environment - - Challenge of the Seventies, Seoul, Sept. 1-4, 1971.

23. Anon. 1970. Agricultural Chemical Yearbook, National Institute for Agriculture, Rep. of Korea.

24. Kwon, ~~Suk~~ Sook Pyo. 1972. Personal Communication.

25. Shin, Sang Chil. 1970. Rice Production in Korea. Pamphlet, Radiation Research Institute in Agriculture, Office of Atomic Energy, ROK.

26. Anon. 1971. Seoul City Statistical Yearbook. Seoul Metropolitan Government.

27. Lee, Hyo-jae. 1971. Life in Urban Korea. Transactions of the Royal Asiatic Society, Korea Branch. XLVI. 1971. Taewon Publ. Co. Seoul, Korea.